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Water-Resources Investigations In Texas

Fiscal Year 1973

U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY
WATER RESOURCES DIVISION
Texas District

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GEOLOGICAL SURVEY

Water Resources Division

Texas District

WATER RESOURCES INVESTIGATIONS IN TEXAS FISCAL YEAR 1973

Austin, Texas

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WATER-RESOURCES INVESTIGATIONS IN TEXAS

FISCAL YEAR 1973

INTRODUCTION

The water-resources investigations in Texas consist of the collection of basic records through the hydrologic-data network, interpretive studies, and research projects. The basic-data records and the results of investigations are published by the Geological Survey or by cooperating agencies. This report describes the water-resources projects and activities of the Geological Survey in Texas for the 1973 fiscal year (July 1, 1972, to June 30, 1973).

The Geological Survey's investigations of the water resources of Texas are under the general direction of I. D. Yost, District Chief. The Texas District office is in the Federal Building, 300 East Eighth Street, Austin, Texas 78701.

Copies of published records, copies of basic data prior to publication, and copies of other unpublished records may be obtained from the District office by request.

Information regarding provisional records of stream discharge prior to publication and other hydrologic data collected within their respective areas may be obtained from the Subdistrict offices in Fort Worth, Houston, San Angelo, San Antonio, and Wichita Falls or the Austin Field Unit in Austin. Requests for information should be addressed as follows:

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COLLECTION OF BASIC RECORDS

A significant activity in the Texas District is the collection of basic hydrologic data. A continuing series of measurements and analyses are made of streamflow, reservoir contents, chemical quality of water, sediment in streams and reservoirs, water levels in wells, and land-surface subsidence.

Modern computer techniques are being used successfully in the collection and publication of water data. By the end of the 1973 fiscal year, the following installations will be in operation: Approximately 400 digital recorders at stream-gaging stations; 25 conductivity recorders; and one instrument for continuously and simultaneously monitoring and recording the water-quality characteristics of conductivity, water temperature, dissolved oxygen, and pH. The use of electronic data processing for printing and storing water records will be expanded.

Surface-Water Records

Continuous-Record Streamflow Stations

As of June 30, 1972, 576 stream-gaging, stage-only, and reservoir-contents stations were in operation. During the 1973 fiscal year, nine stations will be established, and three stations will be discontinued.

Partial-Record Streamflow Stations

Low-flow partial-record stations.--As of June 30, 1972, 110 low-flow partial-record stations were in operation. During the 1973 fiscal year, two stations are scheduled to be established (not listed in summary of scheduled changes in data stations table).

Crest-stage partial-record stations.--As of June 30, 1972, 185 crest-stage partial-record stations were in operation. Of these, 40 were operated in the urban hydrology study areas in Dallas, Houston, and San Antonio. Seven additional stations are scheduled to be established during the 1973 fiscal year (not listed in summary of scheduled changes in data stations table).

Tide-level stations.--As of June 30, 1972, 27 tide-level stations were in operation. During the 1973 fiscal year, six stations will be established (not listed in summary of scheduled changes in data stations table).

Continuous Water-Quality Stations

As of June 30, 1972, one multi-parameter water-quality monitor and 25 conductivity recorders were in operation. No additional conductivity recorders will be established during the 1973 fiscal year. The water-quality monitor is located on the Sabine River and the conductivity recorders are located at stations in the Hubbard Creek, Red, Neches, Brazos, Colorado, and Guadalupe River Basins.

Daily Water-Quality Stations

Daily chemical-quality stations.--As of June 30, 1972, 111 daily chemical-quality stations were in operation. Sufficient samples are collected at these stations to define the total daily chemical loads. During the 1973 fiscal year, no new stations will be established.

Daily suspended-sediment stations.--As of June 30, 1972, 10 daily suspended-sediment stations were in operation. One station will be discontinued during the 1973 fiscal year, and no stations are scheduled to be established.

Partial-Record Water-Quality Stations

Partial-record chemical-quality stations.--As of June 30, 1972, the partial-record chemical-quality network consisted of stations at 138 sites on streams and stations at sites on 55 reservoirs. During the 1973 fiscal year, no new stations will be added to the network.

Special periodic water-quality sampling sites.--Special periodic sampling will be done during the 1973 fiscal year at 136 stations. The analyses will include determinations of standard chemical-quality, BOD (biochemical-oxygen demand), DO (dissolved oxygen), NO_3 (nitrate), PO_4 (phosphate), pH, pesticides in unfiltered water samples and bottom deposits, and minor elements.

Periodic suspended-sediment stations.--The periodic suspended-sediment station network was established in 1966, and as of June 30, 1972, 37 stations were in operation. No expansion of this network is anticipated during the 1973 fiscal year.

Lake and Reservoir Studies

The fiscal 1973 program provides for three water-quality surveys each of Lake Granbury, Whitney Lake, Belton Lake, Livingston Reservoir, Hubbard Creek Reservoir, Lake Arlington, and Possum Kingdom Reservoir and two surveys of Sam Rayburn Reservoir. On-site determinations will be made of specific conductance, dissolved oxygen, temperature, and pH. Samples will be collected for laboratory analyses during each survey.

Summary of Scheduled Changes in Data Stations

Type of record: C--crest-stage partial-record; D--streamflow; G--stage only; L--low-flow partial-record; R--reservoir content; T--tide level

New Stations to be Established

Name of station	Type of record	Cooperation with USGS	Purpose of station and remarks
08061800 East Fork Trinity River at IH 20 below Lake Ray Hubbard near Forney, Tex.	D	City of Dallas through Texas Water Devel. Board	To record the outflow and releases from Lake Ray Hubbard.
08064600 Richland Creek near Fairfield, Tex.	D	Tarrant County WC&ID #1 through Texas Water Devel. Board	Records needed to define the total chemical loads at this proposed dam site.
08067600 Lake Conroe near Conroe, Tex.	R	San Jacinto River Auth. through Texas Water Devel. Board	To provide a record of reservoir contents and to furnish an inventory of water in basin storage.
08067610 Lake Conroe outflow weir near Conroe, Tex.	D	do	To provide assistance in managing and metering releases from Livingston Reservoir.
08067650 West Fork San Jacinto River below Lake Conroe near Conroe, Tex.	D	do	To record the outflow and releases from Lake Conroe.
08068450 Panther Branch near Spring, Tex.	D	Mitchell Devel. Corp. of the Southwest through Texas Water Devel. Board	To study the effects of urbanization in an industrial-residentail environment.
08210400 Lagarto Creek near George West, Tex.	D	Texas Water Devel. Board	Station established to aid in the operation of Lake Corpus Christi and for basin accounting.
08211520 Oso Creek at Corpus Christi, Tex.	D	do	Records needed to define the hydrologic regimen of Oso and Corpus Christi Bays.

Stations to be Discontinued

Name of station	Type of record	Cooperation with USGS	Reason for discontinuance
07336940 McKinney Bayou near Leary, Tex.	C	Texas Highway Dept.	Conditions unsatisfactory for obtaining reliable results at this site.
08042540 East Bay Bayou near Stowell, Tex.	L	Texas Water Devel. Board	Station has been dropped from Galveston Bay project.
08057340 Forney Creek at Lawnview Avenue, Dallas, Tex.	C	City of Dallas	Conditions unsatisfactory for obtaining reliable results at this site.
08063200 Pin Oak Creek near Hubbard, Tex.	D	Texas Water Devel. Board	Sufficient data have been collected to satisfy project objectives.
08065980 Harmon Creek near Riverside, Tex.	L	do	Station is in backwater from Lake Livingston and no longer needed as stage station.
08066000 Trinity River at Riverside, Tex.	G	do	do
08067120 Turtle Bayou near Hankamer, Tex.	L	do	Station has been dropped from Galveston Bay project.
08067250 Turtle Bayou near Anahuac, Tex.	L	do	do
08067520 Goose Creek near McNair, Tex.	L	do	do
08073750 Stoney Brook Street Ditch at Houston, Tex.	C	City of Houston	Sufficient data have been collected to satisfy project objectives.
08074100 Cole Creek at Guhn Road, Houston, Tex.	C	do	do
08074780 Keegans Bayou at Keegan Road near Houston, Tex.	C	do	Removed because of bridge construction.
08074900 Willow Waterhole Bayou at Landsdowne Street, Houston, Tex.	C	do	Indeterminate drainage area results in rainfall-runoff relation being inconclusive.
08075600 Berry Bayou tributary at Globe Street, Houston, Tex.	C	do	do
08075700 Berry Creek at Galveston Road, Houston, Tex.	C	do	Too much effect from backwater--results inconclusive.
08075720 Plum Creek at Houston, Tex.	L	Texas Water Devel. Board	Station has been dropped from Galveston Bay project.
08075740 Little Vince Bayou at Pasadena, Tex.	L	do	do

Stations to be Discontinued--Continued

Name of station	Type of record	Cooperation with USGS	Reason for discontinuance
08075750 Hunting Bayou tributary at Cavalcade Street, Houston, Tex.	C	City of Houston	Indeterminate drainage area.
08076800 Buffalo Bayou tributary at Pasadena, Tex.	L	Texas Water Devel. Board	Station has been dropped from Galveston Bay project.
08076850 Patrick Bayou at Deer Park, Tex.	L	do	do
08077540 Clear Creek at FM 2351 at Friendswood, Tex.	L	do	do
08077640 Dickinson Bayou near Alvin, Tex.	L	do	do
08077680 Highland Bayou near Alta Loma, Tex.	L	do	do
08077800 Halls Bayou near Algoa, Tex.	L	do	do
08077850 Halls Bayou near Alta Loma, Tex.	L	do	do
08077900 Mustang Bayou near Liverpool, Tex.	L	do	do
08078400 Austin Bayou near Liverpool, Tex.	L	do	do
08078700 Flores Bayou near Danbury, Tex.	L	do	do
08091200 Morris Branch near Bluff Dale, Tex.	C	Texas Highway Dept.	Runoff affected by upstream regulation.
08140000 Deep Creek subwatershed No. 8 (Dry Prong Deep Creek) near Mercury, Tex.	D	Texas Water Devel. Board	Sufficient data have been collected to satisfy project objectives.
08140500 Dry Prong Deep Creek near Mercury, Tex.	D	do	do
08162535 Matagorda Bay (Palacios Point) near Palacios, Tex.	T	do	Records no longer needed to define the hydrologic regimen of Matagorda Bay.
08210300 Ramirena Creek near George West, Tex.	D	do	Sufficient data have been collected to satisfy project objectives.
08365550 Franklin Canal at El Paso, Tex.	D	do	do

Stations to be Discontinued--Concluded

Name of station	Type of record	Cooperation with USGS	Reason for discontinuance
08366400 Riverside Canal near Socorro, Tex.	D	Texas Water Devel. Board	Sufficient data have been collected to satisfy project objectives.
08368000 Tornillo Drain at mouth near Tornillo, Tex.	D	do	do
08368300 Tornillo Canal near Tornillo, Tex.	D	do	do
08368900 Hudspeth Feeder Canal near Tornillo, Tex..	D	do	do
08448800 Sonora Field Creek at Sonora, Tex.	C	Texas Highway Dept.	Construction of IH 10.

Ground-Water Records

A network of observation wells for observing fluctuations in ground-water levels, changes in chemical quality of ground water, and subsidence of the land surface is maintained in areas of large ground-water development. The periodic collection of ground-water data can be used in solving such specific problems as over-development and its relation to pumping costs, relationship of recharge to discharge of an aquifer, and the relationship of the quality of ground water to the development and use of the water in storage.

The observation-well network is confined to the areas of continuing ground-water studies in the Houston area, Galveston County and adjacent areas, San Antonio area and Balcones Fault Zone, El Paso area, and Orange County and adjacent areas. As of June 30, 1972, the Geological Survey was monitoring more than 1,200 wells. The types and numbers of observation wells programmed for the 1973 fiscal year by areas are given below.

Area	Water levels		Chemical quality	Subsidence
	Periodic	Continuous		
Houston area	500	6	90	4
Galveston County and adjacent areas	90	2	35	2
San Antonio area and Balcones Fault Zone	8	10	5	0
El Paso area	244	10	21	0
Orange County and adjacent areas	87	1	8	0

PROJECT STUDIES

Hydrologic Studies of Small Watersheds

The U.S. Soil Conservation Service (SCS) has an extensive program of constructing floodwater-retarding structures in small watersheds in Texas. These structures, which are designed to control floodflows and sediment movement, will have varying but important effects on the natural surface- and ground-water resources of river basins, especially where a large number of them are built. The need has grown for basic hydrologic data on these small watersheds to compare the hydrology under natural and developed conditions. It is, therefore, essential that the hydrologic studies determine the extent to which the floodwater-retarding structures affect the volume and mode of occurrence of runoff.

The specific objectives of these studies are:

(1) To determine the net effect of floodwater-retarding structures on the regimen of streamflow at downstream points.

(2) To determine the effectiveness of the structures as ground-water recharge facilities.

(3) To determine the effect of the structures on the sediment yield at downstream points.

(4) To develop relationships between maximum rates and volumes of runoff with rainfall in small natural watersheds.

(5) To develop a stream-system model for basins with floodwater-retarding structures.

(6) To determine the minimum instrumentation necessary for estimating the flood hydrographs below a system of structures, as needed for downstream water-management operations.

Hydrologic studies of SCS-developed areas in Texas, which were started in 1951, are now being made by the Geological Survey in 12 small watersheds to provide the needed data for analyses. The U.S. Soil Conservation Service, Texas Water Development Board, San Antonio River Authority, city of Dallas, and the Tarrant County Water Control and Improvement District No. 1 are cooperating with the Geological Survey in these studies. The 12 study areas are chosen on a Statewide basis to sample watersheds having different rainfall, topography, geology, and soils. In five of the study areas, streamflow and rainfall records were collected prior to construction of the floodwater-retarding structures, thus affording the opportunity for analyses of the hydrologic conditions before and after construction.

The 12 study areas, which are in four major river basins, are North Creek, Elm Fork Trinity River, Little Elm Creek, Honey Creek, and Pin Oak Creek, all in the Trinity River Basin; Green Creek, Cow Bayou, Little Pond-North Elm Creeks, in the Brazos River Basin; Deep Creek and Mukewater Creek in the Colorado River Basin; and Escondido Creek and Calaveras Creek in the San Antonio River Basin.

The long-range plan for the small-watershed studies specified that the data-collection program in each study area be skeletonized when data were sufficient to accomplish the objectives as limited by the instrumentation in the particular study area. In keeping with this plan, data-collection programs have been skeletonized as follows: Green Creek study area in 1967; Elm Fork Trinity River and Calaveras Creek study areas in 1968; Honey Creek study area in 1969; and Escondido Creek study area in 1970.

During the 1972 fiscal year, basic-data reports, which present a compilation of the annual hydrologic data, were prepared for each study area. A reevaluation of the long-range plan led to discontinuing rain-gage networks in October 1971 in the following skeletonized study areas: Green Creek, Honey Creek, Deep Creek, Escondido Creek, and Calaveras Creek. Data collection in the North Creek study area was expanded to include five floodwater-retarding structures completed during the year.

During the 1973 fiscal year, further reductions in data collection and analysis will be initiated in this project. All data collection in the Pin Oak Creek study area will be discontinued October 1, 1972. The annual preparation of basic-data reports and storm analyses will be discontinued for all skeletonized study areas. An interpretive report on studies in the Honey Creek area will be completed during fiscal year 1973.

Urban-Hydrology Studies

Society is confronted with the most urgent water problems in urban areas, where residential, commercial, and industrial complexes may be subject to potentially destructive floods and where lives and vast sums of money can be saved if metropolitan drainage systems and water-control facilities are properly planned.

Because undeveloped land is being converted to urban use, the amount of impervious surface area is increased, which results in a change in the runoff pattern. Higher peak discharges may result and may be accompanied by more rapid removal of the storm runoff. Drainage systems that were constructed prior to urbanization must be redesigned to function properly under conditions of ultimate land development. Because of these requirements, hydrologic data are needed to define the effects of urbanization on the magnitude of floodflow and runoff from small drainage areas.

The Geological Survey, in cooperation with State and local agencies, is making hydrologic studies in the Austin, Dallas, Dallas County, Houston, Fort Worth, and San Antonio areas. These studies will provide data necessary for defining the changes in storm runoff resulting from progressive urban development and for defining flood boundaries and depths of inundation for floods of various magnitudes and frequencies.

Austin Project

The Austin project, which began in 1954, is in cooperation with the Texas Water Development Board. The objectives of the project are to provide basic rainfall and runoff data and to provide data showing the effects of progressive urbanization on infiltration, rates of peak discharge, and rainfall-runoff relations. The project also provides applied research facilities for students at the University of Texas at Austin.

The study involves the collection of rainfall and runoff data in the Waller Creek Basin, a 4.13-square-mile urban watershed in Austin and in the Wilbarger Creek Basin, a 4.61-square-mile rural watershed 15 miles northeast of Austin. The data collected in the Wilbarger Creek area which is comparable in size, climate, and geology to the Waller Creek study area will be used for comparison.

Data are being collected from three recording and three nonrecording rain gages and from the two continuous-record stream-gaging stations in the urban watershed of Waller Creek. Three recording rain gages and one continuous-record stream-gaging station provide data from the Wilbarger Creek watershed.

Data collection during the 1973 water year will continue at about the same level as in 1972. Basic-data reports, which contain graphical and tabular data on the rates and volumes of rainfall and runoff from major storms each year, will continue to be prepared annually.

Houston Project

The Houston project, which began in 1964, is in cooperation with the city of Houston and the Texas Water Development Board. The objective of the project is to provide data on the magnitude, frequency, and changes in characteristics of floods that result from progressive urban development.

The data-collection network consists of seven continuous-record stream-gaging stations, 17 crest-stage partial-record stations (each having recording rain gages), and five weighing-type recording rain gages.

The program was expanded during the 1969 fiscal year to include collection of water-quality data on chemical quality, nutrients, BOD, pesticides, and sediment. During the 1972 fiscal year, periodic chemical-quality samples were collected at six additional sites, and samples for coliform counts and minor-element analyses were collected at 17 sites.

Program changes in fiscal 1973 will include discontinuing eight flood-hydrograph gages, establishing eight recording rain gages and collecting additional samples for water-quality studies. Basic-data reports, presenting graphical and tabular data for rates and volumes of rainfall and runoff, will continue to be prepared annually. An interpretive report is scheduled for publication in 1973.

Dallas Project

The Dallas project, which began in 1961, is in cooperation with the city of Dallas. Data collection is expected to permit analyses aimed at achieving the following objectives: To define the changes in storm runoff resulting from progressive urban development; to define the frequency and magnitude of floods on small urban watersheds; and to define flood boundaries and depths of inundation for floods of various magnitudes and frequencies in and along streams traversing the Dallas metropolitan area.

During the 1973 fiscal year, the following changes will be made: Data collection at 87 flood-profile gages, seven recording rain gages, and one flood hydrograph gage will be discontinued and data collection will begin at three dual-digital flood-hydrograph gages. Rainfall and flood-stage or discharge data will continue to be collected at six continuous-record stream-gaging stations, 10 crest-stage partial-record stations, two flood-profile stations, and 29 recording rain-gage stations (including nine gages at partial-record stations). This extensive hydrologic network covers the White Rock Creek, Turtle Creek, Bachman Branch, Joes Creek, Fivemile Creek, Cedar Creek, and Coombs Creek watersheds in Dallas.

Basic-data reports, presenting graphical and tabular data for rates and volumes of rainfall and runoff each year, will continue to be prepared annually. An interpretive report to evaluate the effects of urbanization in the Dallas metropolitan area is scheduled for publication in the 1973 fiscal year.

San Antonio Project

The San Antonio project was initiated in 1968 in cooperation with the Texas Water Development Board. The objectives of the project are to collect data on rainfall and runoff in an urban area to define the effects of urbanization on the regimen of streamflow. The data-collection network consists of three continuous streamflow recorders, four flood-profile gages, six stage-rainfall (dual-digital) gages, and nine recording rain gages.

The data-collection program was expanded during the 1969 fiscal year to include samples collected and analyzed periodically from 11 streamflow sites. Results of these analyses will be included in the annual basic-data reports. Analyses scheduled are: Standard chemical, nutrients, BOD, pesticides, and sediment. The program for 1971 was expanded slightly by the addition of a sediment station at Olmos Creek at Dresden Drive. In 1972 the gaging station at Olmos Reservoir was discontinued.

Data collection during the 1973 water year will continue at about the same level as in 1972. Basic-data reports will continue to be published at the end of each water year.

Fort Worth Project

The Fort Worth project was initiated during the 1969 fiscal year in cooperation with the city of Fort Worth. The objectives of the project are to provide data for a logical approach to flood-zoning and flood-protection problems and to analyze the effects of progressive urbanization on runoff. The data will also be useful in the design of storm sewers, culverts, and bridges.

The data-collection network consists of two continuous streamflow recorders, two stage-rainfall partial-record recorders, five rainfall recorders, and 19 crest-stage flood-profile gages. These instruments are located in the Little Fossil and Dry Branch watersheds.

During 1970, the network was expanded by the addition of three continuous streamflow stations and four recording rain gages in the Sycamore Creek watershed and a special study area (Seminary South Shopping Center). During the 1971 fiscal year 16 crest-stage flood-profile gages were added in the Sycamore Creek watershed.

Data collection during the 1973 water year will continue at about the same level as in 1972. Basic-data reports will continue to be published at the end of each water year.

Dallas County Project

The Dallas County urban hydrology study was initiated during the 1969 fiscal year in cooperation with the Dallas County Department of Public Works. The objectives of the project are to provide data necessary for a logical approach to flood-zoning and flood-protection problems and to analyze the effects of progressive urbanization on runoff. These data will also be useful in the design of storm sewers, culverts, and bridges. The study area constitutes all of Dallas County exclusive of the city of Dallas and contains many rapidly urbanizing communities. Those cities in the 20,000 to 70,000 population class include Farmers Branch, Garland, Grand Prairie, Irving, Mesquite, and Richardson. Other communities (less than 11,000 population) include Cedar Hill, Duncanville, DeSoto, Kleberg, Lancaster, Rowlett, Seagoville, and Sunnydale.

The first year's instrumentation consisted of one continuous-streamflow recorder, two stage-rainfall (dual-digital) recorders, seven rain-gage recorders, and 21 flood-profile crest-stage gages. These instruments are located in the Duck Creek and South Mesquite watersheds.

During the 1970 fiscal year, the network was expanded by instrumenting Tenmile Creek watershed with one continuous streamflow station, eight flood-profile crest-stage gages, and five recording-rain gages.

Data collection during the 1973 water year will continue at about the same level as in 1972. Basic-data reports will be prepared at the end of each water year.

Flood Stages and Discharges for Small Streams in Texas (Highway Program)

The highway program, which began in 1965, is in cooperation with the Texas Highway Department and the U.S. Department of Transportation, Federal Highway Administration. The objective of the project is to define the frequency and magnitude of floods on small rural watersheds having drainage areas of less than 20 square miles. This information is needed to establish criteria for properly designing culverts and bridges on highways. Toward this end, 150 crest-stage partial-record stations have been established throughout Texas. Data on flood magnitudes and volumes and on rainfall amounts and intensities are being obtained at each station.

The first report--a compilation of all peak-discharge data collected in Texas through September 30, 1963, for streams draining about 100 square miles or less--was printed in 1966. This report, entitled "Floods on Small Streams in Texas" was released in January 1966, as Texas District open-file report no. 89.

Interim report no. 85-2 was released in December 1967, as Texas District open-file report no. 107. This report contains a tabulation of the maximum annual-discharge data through the 1966 water year at 134 sites that have drainage areas of less than 20 square miles. The report also contains a tabulation of rainfall and runoff data from significant storms at 120 sites.

Interim report no. 85-3, containing data through the 1967 water year for 185 sites, was distributed in May 1969.

Interim report no. 85-4, containing data through the 1968 water year for 225 sites, was distributed in May 1971.

Interim report no. 85-5, containing data through the 1969 water year for 225 sites, was distributed in April 1972.

Interim report no. 85-6, containing data through the 1970 water year for 235 sites, was distributed in February 1973.

The data-collection phase of the program for the 1973 fiscal year will be a continuation of the 1972 program. An interim report on regionalization of flood characteristics, applicable for small drainage areas generally east of Interstate Highway 35, will be prepared in 1973.

Chemical and Physical Characteristics of Water in Estuaries of Texas

This study, begun in October 1967, is in cooperation with the Texas Water Development Board. The full development of the water resources of Texas must provide for the use and preservation of the valuable water resources of the estuaries. The objectives of the study are to collect data on water temperature, pH, dissolved constituents, concentration of nutrients (phosphorus and nitrogen compounds), minor elements, water velocities and directions, and other data necessary to define the source and distribution of nutrients, current patterns and rates of movement, and the physical and organic water quality in areal distribution and time variation.

The major data-collection program in the 1973 fiscal year will be in the Lavaca-Tres Palacios, Mission-Aransas, Guadalupe, and Nueces estuaries, but data will also be obtained on other estuaries of the Texas Coast.

Special investigations to determine the quantity and quality of fresh-water inflow and the exchange of water between Lavaca-Tres Palacios estuary and the Gulf of Mexico will be made during fiscal year 1973.

To supplement available tide-stage records being obtained by the U.S. Army Corps of Engineers and U.S. Geological Survey, 19 tide-stage gages funded by the Corps of Engineers are operated by the Geological Survey. Nine additional tide-stage gages are operated as part of the cooperative program with the Texas Water Development Board. Six additional tide-stage gages will be established as part of the cooperative program with the Texas Water Development Board during the 1973 fiscal year.

The basic data will be released to interested agencies on as timely a basis as possible and will also be released in an annual basic-data compilation. Interpretive reports will be prepared as the data warrant.

Pesticides Program

The Geological Survey pesticides laboratory in Austin makes monthly analyses for a Federal network of stations on streams throughout the western states. Two stations in Texas are included in the network.

Programs in cooperation with the Texas Water Development Board provide for studies of the quantities of chlorinated hydrocarbon pesticides in water and bottom sediments at a network of surface-water stations, in runoff in the Houston and San Antonio urban areas, and in selected wells in counties where ground-water studies are in progress.

Continuing Ground-Water Studies

The continuing ground-water studies are detailed studies that are designed to keep abreast of and to evaluate the effects of large withdrawals of ground water in the areas of concentrated pumping. The need for ground-water information in these areas is determined by the particular problems of the area, and the programs of continuing study are carefully planned to meet specific objectives.

Houston Area

The ground-water study in the Houston district, which began on a more or less continuous basis in 1929, is in cooperation with the Texas Water Development Board and the city of Houston. The program proposed for 1973 is a continuation of basic-data collection. Items of work will include an inventory of all new large-capacity wells; periodic measurements of water levels in about 500 observation wells; operation and maintenance of six continuous water-level recorders and two compaction recorders; collection of water samples annually from about 90 wells for chemical analyses; conducting pumping tests on new large-capacity wells; and an inventory of annual municipal, industrial, and irrigation pumpage. Basic-data reports will be prepared periodically.

Galveston County

The ground-water study in Galveston County, which began in 1931, is in cooperation with the Texas Water Development Board and the city of Galveston. The program for several years has consisted of a compilation and tabulation of water records, including records of water-level fluctuations, changes in water quality, pumpage, and land-surface subsidence. For 1973, the program consists of semi-annual measurements of water levels in 90 observation wells, operation and maintenance of two continuous water-level recorders, observation of the chemical quality of water in 35 wells, inventory of all municipal and industrial pumpage, and observance of the effects of land-surface subsidence. Basic-data reports will be prepared periodically.

El Paso Area

The ground-water study in the El Paso area began in 1935 in cooperation with the Texas Water Development Board and the city of El Paso. The program for the 1973 fiscal year is in three parts. The first part of the program consists of a continuation of the collection of basic hydrologic data in the Hueco Bolson and Mesilla Valley, measuring about 200 wells annually, 10 semi-annually, 30 quarterly, four monthly, and 10 continuously with water-level recorders, inventorying all new wells (excluding shallow irrigation wells), making aquifer tests of large-capacity wells, and collecting water samples from about 21 wells.

The second and third parts of the program consist of completion of a mathematical model of the Hueco Bolson in Texas and determining the feasibility of a model of the lower Mesilla Valley.

San Antonio Area and Balcones Fault Zone

The ground-water study in the San Antonio area and Balcones Fault Zone, which began in 1949, is in cooperation with the Texas Water Development Board, Edwards Underground Water District, and the San Antonio City Water Board. The objectives of the study are to appraise quantitatively the ground-water resources in the San Antonio area and along the Balcones Fault Zone from Kinney County to the Hays-Travis County line and to continue to investigate the cause and effect relationships in the Edwards underground reservoir.

The 1973 program consists of continuing to collect and analyze the basic geologic and hydrologic data and to refine the previous evaluations. Items of work include the periodic measurements of water levels in eight wells; operation and maintenance of continuous water-level recorders on 10 wells; collection of water samples from five wells for chemical analyses of inorganic elements and from 50 wells for some but not all inorganic, biologic, and minor elements and pesticides; collection and compilation of records from 10 rain-gaging stations; inventory of all large-capacity well pumpage and spring discharge; inventory of new wells; and mapping of the principal recharge area of the Edwards underground reservoir. A report summarizing the discharge from the reservoir will be prepared for release in fiscal year 1973.

Orange County and Adjacent Areas

The ground-water study in the Orange County area, which began in 1967, is in cooperation with the Texas Water Development Board and the Sabine River Authority of Texas. The purpose of this study is to keep abreast of the effects of ground-water development in the area and especially to monitor the fresh-water--salt-water interface as a guide to future development of ground water in Orange and adjacent counties to prevent further salt-water intrusion. The magnitude of industrial and municipal development in the area greatly increases the gravity of the situation.

The 1973 fiscal-year program will consist of the inventory of all new large-capacity wells, including the collection of drillers' logs, electrical logs, and well-construction information; measurements of water levels in about 87 observation wells on a semi-annual basis; operation and maintenance of one continuous water-level recorder; and the location of additional wells suitable for water-level recorders. In addition, water samples from about 58 wells are to be collected annually for chemical analysis; annual municipal and industrial pumpage is to be inventoried; and all data currently and previously collected are to be analyzed, interpreted, and correlated.

Other Interpretive Studies

Water Resources of Big Bend National Park

This study, which began in July 1966, is in cooperation with the National Park Service. The objective of the study is to determine the available sources of water for Big Bend National Park. The program in the 1973 fiscal year will include the drilling of a test hole at Cenizo Flats.

Artificial-Recharge Research on the High Plains of Texas and New Mexico

This research project, which began during the 1968 fiscal year, is financed wholly by Federal funds. The study will provide information needed in connection with artificial recharge of water obtained from the playa lakes or imported to the High Plains. The study will also provide the opportunity for applied research on methods of artificial recharge. During the 1973 fiscal year, special emphasis is being placed on recharge from the surface through spreading ponds. Additional work is being done on problems associated with recharge through wells, such as the control of sediment in recharge water.

A report summarizing previous work on artificial recharge on the High Plains will be available in the 1973 fiscal year. Reports on specific aspects of the recharge studies will be prepared when warranted.

Water Resources of Guadalupe Mountains National Park

This study was begun during the 1969 fiscal year in cooperation with the National Park Service. The objectives are to appraise the water resources of this newly established park. Because the present water supply of the area--obtained from wells and springs--is inadequate for anticipated needs, the study will include a complete inventory of wells and springs with particular attention to those areas of immediate need (Frijoles Ranch site, McKittrick Canyon, and the Bowl). In 1973, two test holes will be drilled at or near the site of the Visitor's Center at the Frijoles Ranch site.

Hydrologic Research Studies of the Edwards and Associated Limestones

This ground-water study is in cooperation with the Texas Water Development Board, the Edwards Underground Water District, and the San Antonio City Water Board. All indications, both past and present, indicate that the Edwards Limestone reservoir will, in time, become totally developed (in the amount of the natural recharge), and that it will then become necessary to integrate the use of water from the Edwards with water imported from other sources. At that time, it will be necessary to know in as much detail as possible how to get the most water from the Edwards with the least waste, with a minimum conflict between users, and with a minimum detriment to those users who are in less favorable locations.

This study will provide for the complete appraisal of the availability of water in the Edwards aquifer, thereby furnishing valuable and detailed information not now available to all agencies that may be concerned with water management.

During the 1973 fiscal year, at least one test hole will be drilled and cored on the bad-water line west of San Antonio, and additional test holes will be drilled and cored if funds are available. Geothermal, tracer, and stable-isotope studies; geophysical logging of available wells; evaluation of streamflow records to determine recharge to the reservoir; and studies of the relationship between precipitation and recharge will be continued. Water-level changes will be obtained from eight recording observation wells, 10 wells measured monthly, and approximately 180 wells measured semi-annually. Water samples for chemical analysis for some but not all inorganic and minor elements will be collected from about 20 wells along the bad-water line.

Analog-Model Study of Ground Water in the Houston Area

In 1962-63, an analog model was made of the aquifers underlying the Houston area. This work was done in cooperation with the city of Houston and the Texas Water Development Board. The model successfully duplicated the performance of the aquifer in the heavily developed areas in the immediate vicinity of Houston, but in the adjoining rice-irrigation area, the model failed to duplicate the history of performance, nor did the model successfully duplicate the performance of the Alta Loma Sand, one of the layers modeled. Although the model served the immediate needs of the city of Houston, future plans for ground-water development by the city required that the model be refined so that the conditions in the area to the west of the city, including the rice-irrigation area, be properly simulated. This project is in cooperation with the city of Houston and the Texas Water Development Board. The construction of the model and preparation of the report will be completed in 1973.

Relationship of Ground Water to Surface Water at the Proposed Palmetto Bend Reservoir

At the request of the Bureau of Reclamation, the Geological Survey initiated this project in the 1971 fiscal year. The objectives of the project are to evaluate the possible loss of the base flow of the Lavaca and Navidad Rivers because of heavy ground-water pumping and to outline areas of potential land-surface subsidence. The conclusions may indicate a need for the Bureau to reassess inflow and yield of the proposed reservoir and to consider the possible effects of subsidence on the height and length of the dam embankment, on the spillway design, and on backwater and surface-drainage problems--all important to successful construction and operation of the Bureau's Palmetto Bend project. The results of the investigation will be released in an open-file report in 1973.

Ground-Water Study of the Upper Red River Basin

At the request of the Corps of Engineers, Tulsa District, the Survey will make a study of ground-water availability in the Red River Basin above Denison Dam. The overall project will be under the direction of the Oklahoma District. Personnel of the Texas District will be assigned to the project to carry out the work in the Texas part of the basin. Compilation of the data for the Texas part of the project is scheduled for 1973. A report will be available, at least in preliminary form, by the end of the 1973 fiscal year.

Trinity River Alluvium Study

At the request of the U.S. Corps of Engineers, Fort Worth District, the Geological Survey initiated a study of the Trinity River alluvium at the beginning of the 1972 fiscal year. The objectives of the study are to define the ground-water conditions in the alluvium of the Trinity River Valley between Dallas and the Gulf Coast and project the effects on the ground-water system by the impoundment of water behind navigational locks and dams. This work is in connection with the canalization of the Trinity River by the Corps.

Work planned during the 1973 fiscal year includes a drilling program in the alluvium along a second segment of the river reach, inventory of wells, establishment of a water-level observation-well program, collection of water samples for chemical analyses, performance of pumping tests, collection of formation samples for laboratory analyses, and the initial construction of a digital model for the first segment of the alluvium. A report on the post-construction conditions for this first segment and a second progress report will be prepared at the end of the fiscal year.

Rio Grande Environmental Study

The present water needs (exclusive of irrigation) of the El Paso area are supplied almost entirely from ground-water sources. The known available supplies of fresh ground water are large, but for future growth, additional sources of water need to be identified. The need for the study is to provide reliable information on the amounts and quality of fresh and slightly saline ground water available for development in the Salt Basin, Quitman and Presidio Bolsons, Mesilla Valley, and La Mesa Bolson.

The 1973 program, in cooperation with the Texas Water Development Board, will include completing gravity and resistivity surveys, preparing plans and specifications for seismic and test-drilling operations, obtaining permits for rights-of-access to privide lands for geophysical and drilling operations, and inventorying major wells in the bolsons.

Land-Surface Subsidence in the Baytown Area

The objectives of this study, which is in cooperation with the Corps of Engineers, is to determine the rates and amount of subsidence in the Baytown area and to predict the rate and amount of subsidence for use in planning and constructing the proposed levee or other protective measures.

Extensive development of ground-water supplies and the production of oil and gas in the greater Houston area has caused large pressure declines in the fresh-water aquifers and petroleum reservoirs, resulting in compaction of the fine-grained sediments. In some parts of the area, the compaction has resulted in as much as 6 feet of land-surface subsidence. Near the bays, the subsidence has caused tidal flooding that will probably require the construction of protecting levees.

The collection of data on the relation of pressure decline to compaction will continue during fiscal year 1973. These data include inventories of ground-water pumpage and oil and gas production and a delineation of the pressure decline due to each. A study will be made of the subsurface deposits by the use of drillers' logs and electrical logs to determine the thickness of clay beds and sand beds and to determine the composite clay thickness. Two wells will be drilled to obtain clay cores and to install pore-pressure measuring devices. A report summarizing the results obtained during 1972 will be prepared in fiscal year 1973.

Mapping of Flood-Prone Areas

The U.S. Geological Survey is mapping flood-prone areas in Texas by delineating on existing topographic maps the outline of the 100-year flood. This program is part of a Nationwide Federal program designed to aid in reducing flood losses and damage. In addition, the Geological Survey, in cooperation with the Department of Housing and Urban Development, is mapping the flood hazards in mainly urban areas so that actuarial rates can be assigned by the Federal Insurance Administration. The programs will continue through fiscal year 1973, and additional maps and pamphlets, which show the areas of potential flood damage, will be issued as they are completed.

Galveston Bay Inflow Study

The objective of this project, which is in cooperation with the Texas Water Development Board, is to determine the quantity and quality of runoff from rural and urban areas to the Galveston Bay system. During fiscal year 1973, data collection will include tributary discharge, inorganic and organic chemical parameters, bacteria counts, and pesticide concentrations at 14 sites.

Ground-Water Pollution Study of Toledo Bend Reservoir

An expected large increase in the disposal of sewage by septic tanks along the shoreline of Toledo Bend Reservoir is a possible source of pollution of the impounded water. An understanding of the movement of the shallow ground water, including any effluent, will be the basis for controlling and regulating the sewage disposal.

Work during the 1973 fiscal year, in cooperation with the Sabine River Authority of Texas, will continue to be directed toward determination of the direction of flow and gradient of the water table and determination of the chemical and biological quality of the shallow ground water within a 2-mile zone bordering the reservoir on the Texas side only; by using a network of selected wells, the quality of the ground water and the fluctuations of the water table will be monitored periodically. Open-file reports will be prepared during the 1973 fiscal year.

Land-Surface Subsidence in the Texas City and Seabrook Areas

The extensive development of ground water and production of oil and gas in Harris and Galveston Counties has caused large pressure declines in the fresh-water aquifers and in the petroleum reservoirs. This decline in pressure has caused compaction of the fine-grained material and has resulted in as much as 9 feet of land-surface subsidence in parts of the area. Lowering of the surface near the bays has subjected land to inundation. High tides cause flooding of the lowland, and much larger areas are subject to flooding by hurricane tides.

The Corps of Engineers, in its concern for losses caused by hurricane flooding, has developed protection plans that include the construction of levees. The objectives of this study are to predict the amounts and rates of subsidence for use in planning, constructing, and maintaining the levees and holding ponds used for protection.

Existing data on geology, hydrology, ground-water and oil production, water levels, and declines in water levels will be collected and analyzed. Undisturbed samples of clay will be taken from test holes at Texas City and Seabrook and analyzed for consolidation characteristics and permeability. Observation wells will be installed at both sites to determine existing pressure profiles and reaction with time. Borehole extensometers will be constructed at each site. Using all data collected, an estimate of subsidence (rate and amount) will be made by using principles of soil mechanics. A formal report to describe the results will be submitted by the early part of 1974.

Time-of-Travel Studies

Sabine River.--The objectives of this project, which is in cooperation with the Sabine River Compact Administration are to field check the results of previous studies that determined the stream velocity by developing equations based on hydraulic geometry and to provide data for a hydrologic model of the river system. During fiscal year 1972, a dye study was made to determine the travel time in the reach of the Sabine River from Lake Tawakoni to Toledo Bend Reservoir under low-flow conditions. Water-quality data were also obtained to aid in development of the model. A similar study was made for reaches of Lake Fork Creek and Big Sandy Creek. A report on these studies will be published in 1973.

Trinity River.--In 1973, the Corps of Engineers requested a study on the Trinity River to determine the probable time-of-travel of a pollutant and the oxygen "sag" under low-flow conditions. These data will be used in developing a hydrologic model of the river system. A dye was used as a tracer to determine the travel time for different reaches of the river from Fort Worth to Interstate Highway 10. The results of this study will be published in 1973.

Salt-Water Encroachment, Houston Area

The ultimate objectives of the study, in cooperation with the city of Houston and the Texas Water Development Board, are to determine the location of the fresh-water--salt-water interfaces in the aquifers and to determine the rates of movement of the salt water towards centers of pumping.

The extensive development of ground water in the greater Houston area has caused movement of saline water into the fresh-water sands. Increases of chloride concentrations in fresh ground water have been measured adjacent to interfaces in Galveston and Harris Counties for many years. Salt-water contamination in shallow wells in the vicinity of the Houston Ship Channel has been reported. Recently, water from a well completed in the Chicot aquifer near the channel in the vicinity of Houston has become salty. The Chicot aquifer is the major aquifer in Galveston County and southeastern Harris County.

REPORTS IN PREPARATION, RELEASED, OR PUBLISHED DURING FISCAL YEAR 1973

Basic-Data Reports

Water-Resources Data for Texas

Water resources data for Texas, 1971 - Part I: Surface-water records. Records for the 1971 water year (October 1970 - September 1971), published as a U.S. Geological Survey annual report.

Water resources data for Texas, 1970 - Part II: Water-quality records. Records for the 1970 water year (October 1969 - September 1970), will be published as a U.S. Geological Survey annual report.

Hydrologic Studies of Small Watersheds

Annual compilation and analysis of hydrologic data for North Creek, Trinity River Basin, Texas, 1971. Limited number of copies to be reproduced by the Texas District.

Annual compilation and analysis of hydrologic data for Elm Fork Trinity River, Trinity River Basin, Texas, 1971. Limited number of copies to be reproduced by the Texas District.

Annual compilation and analysis of hydrologic data for Little Elm Creek, Trinity River Basin, Texas, 1971. Limited number of copies to be reproduced by the Texas District.

Annual compilation and analysis of hydrologic data for Honey Creek, Trinity River Basin, Texas, 1971. Limited number of copies to be reproduced by the Texas District.

Annual compilation and analysis of hydrologic data for Pin Oak Creek, Trinity River Basin, Texas, 1971. Limited number of copies to be reproduced by the Texas District.

Annual compilation and analysis of hydrologic data for Green Creek, Brazos River Basin, Texas, 1971. Limited number of copies to be reproduced by the Texas District.

Annual compilation and analysis of hydrologic data for Mountain Creek, Trinity River Basin, Texas, 1971. Limited number of copies to be reproduced by the Texas District.

Annual compilation and analysis of hydrologic data for Cow Bayou, Brazos River Basin, Texas, 1971. Limited number of copies to be reproduced by the Texas District.

Annual compilation and analysis of hydrologic data for Deep Creek, Colorado River Basin, Texas, 1971. Limited number of copies to be reproduced by the Texas District.

Annual compilation and analysis of hydrologic data for Mukewater Creek, Colorado River Basin, Texas, 1971. Limited number of copies to be reproduced by the Texas District.

Annual compilation and analysis of hydrologic data for Escondido Creek, San Antonio River Basin, Texas, 1971. Limited number of copies to be reproduced by the Texas District.

Annual compilation and analysis of hydrologic data for Calaveras Creek, San Antonio River Basin, Texas, 1971. Limited number of copies to be reproduced by the Texas District.

Annual compilation and analysis of hydrologic data for Little Pond and North Elm Creeks, Brazos River Basin, Texas, 1971. Limited number of copies to be reproduced by the Texas District.

Urban-Hydrology Studies

Annual compilation and analysis of hydrologic data for urban studies in the Fort Worth, Texas, metropolitan area, 1971. Limited number of copies to be reproduced by the Texas District.

Annual compilation and analysis of hydrologic data for urban studies in the Houston, Texas, metropolitan area, 1971. Limited number of copies to be reproduced by the Texas District.

Annual compilation and analysis of hydrologic data for urban studies in the Dallas, Texas, metropolitan area, 1971. Limited number of copies to be reproduced by the Texas District.

Annual compilation and analysis of hydrologic data for urban studies in the Austin, Texas, metropolitan area, 1971. Limited number of copies to be reproduced by the Texas District.

Annual compilation and analysis of hydrologic data for urban studies in the San Antonio, Texas, metropolitan area, 1971. Limited number of copies to be reproduced by the Texas District.

Flood Stages and Discharges for Small Streams in Texas (Highway Program)

Flood stages and discharges for small streams in Texas, 1970. This report has been released as a U.S. Geological Survey open-file report (Research Study 4-5-65-85, Interim report no. 85-6).

Flood stages and discharges for small streams in Texas, 1971. Limited number of copies to be reproduced by the Texas District.

Ground-Water Basic-Data Reports

Development of ground water in the Orange County area, Texas and Louisiana, 1963-71. This report was published as Texas Water Development Board Report 156.

Ground-water discharge from the Edwards and associated limestones, San Antonio area, Texas, 1971. This report was published as Edwards Underground Water District Bulletin 29.

Ground-water discharge from the Edwards and associated limestones, San Antonio area, Texas, 1972. This report will be published as an Edwards Underground Water District Bulletin.

Drillers' logs of wells in Harris County, Texas. This report has been released to the open file and will be published as a Texas Water Development Board report.

Chemical analyses of water from wells in Harris County, Texas, 1922-71. This report has been released to the open file and will be published as a Texas Water Development Board report.

Records of wells in Harris County, Texas. This report has been released to the open file and will be published as a Texas Water Development Board report.

Other Basic-Data Reports

Selected water-quality records for the Texas surface waters, 1970 water year. This report was published as Texas Water Development Board Report 149.

Water-quality records for the Hubbard Creek watershed, Texas, October 1969 - September 1971. This report has been released to the open file. A limited number of copies will be reproduced by the Texas District.

Chemical and physical characteristics of water in estuaries of Texas, October 1969 - September 1970. This report has been released to the open file and will be published as a Texas Water Development Board report.

Water-quality records for selected reservoirs in Texas and adjoining areas, 1970-71. This report has been released to the open file. A limited number of copies will be reproduced by the Texas District.

Biochemical-oxygen-demand, dissolved-oxygen, selected-nutrients, and pesticide records of Texas surface waters, 1971. This report has been released to the open file and will be published as a Texas Water Development Board report.

Pesticides in western streams, 1968-71. This report will be published in the Pesticides Monitoring Journal.

Analytical or Interpretive Reports

Hydrologic Studies of Small Watersheds

Hydrologic studies of small watersheds, Calaveras Creek, San Antonio River Basin, Texas, 1955-68. This report was published as Texas Water Development Board Report 154.

Hydrologic studies of small watersheds, Green Creek, Brazos River Basin, Texas, 1955-66. This report was published as Texas Water Development Board Report 159.

Hydrologic studies of small watersheds, Honey Creek, Trinity River Basin, Texas, 1953-69. This report is scheduled to be published as a Texas Water Development Board report.

Reconnaissance Studies of the Chemical Quality of Texas Streams

Reconnaissance of the chemical quality of surface waters of the Rio Grande Basin, Texas. This report has been released to the open file and will be published as a Texas Water Development Board report.

County Ground-Water Appraisal Studies

Ground-water resources of Fort Bend County, Texas. This report was published as Texas Water Development Board Report 155.

Ground-water resources of Wheeler and eastern Gray Counties, Texas. This report has been released to the open file and will be published as a Texas Water Development Board report.

Ground-water resources of Brazoria County, Texas. This report has been released to the open file and will be published as a Texas Water Development Board report.

Ground-water resources of Donley County, Texas. This report has been released to the open file and will be published as a Texas Water Development Board report.

Ground-water resources of Dickens and Kent Counties, Texas. This report was published as Texas Water Development Board Report 158.

Ground-water resources of Navarro County, Texas. This report has been released to the open file and will be published as a Texas Water Development Board report.

Ground-water resources of Washington County, Texas. This report has been released to the open file and will be published as a Texas Water Development Board report.

Ground-water resources of Blanco County, Texas. This report has been released to the open file and will be published as a Texas Water Development Board report.

Ground-water resources of Kleberg, Kenedy, and southern Jim Wells Counties, Texas. This report has been released to the open file and will be published as a Texas Water Development Board report.

Ground-water resources of Coke County, Texas. This report has been released to the open file and will be published as a Texas Water Development Board report.

Ground-water resources of Hall and Briscoe Counties, Texas. This report has been released to the open file and will be published as a Texas Water Development Board report.

Ground-water resources of Hardeman County, Texas. This report was published as Texas Water Development Board Report 161.

Ground-water resources of Rains and Van Zandt Counties, Texas. This report has been released to the open file and will be published as a Texas Water Development Board report.

Ground-water resources of Floyd and Motley Counties, Texas. This report has been released to the open file and will be published as a Texas Water Development Board report.

Ground-water resources of Val Verde County, Texas. This report has been released to the open file and will be published as a Texas Water Development Board report.

Ground-water resources of Brazos and Burleson Counties, Texas. This report has been released to the open file and will be published as a Texas Water Development Board report.

Ground-water resources of Duval County, Texas. This report has been released to the open file and will be published as a Texas Water Development Board report.

Ground-water resources of Grimes County, Texas. This report has been released to the open file and will be published as a Texas Water Development Board report.

Other Analytical or Interpretive Reports

Water budget and quality of water of Hubbard Creek Reservoir, Texas, 1963-67 water years. This report was published as Texas Water Development Board Report 151.

Development of ground water in the Houston District, Texas, 1966-69. This report was published as Texas Water Development Board Report 152.

Development of ground water in the El Paso District, Texas, 1963-70. This report was published as Texas Water Development Board Report 153.

Floods of September - October 1967 in south Texas and northeastern Mexico. This report has been released to the open file and will be published by the U.S. Geological Survey as a Water-Supply Paper.

Urban hydrology of the Houston, Texas, metropolitan area. This report has been released for publication as a U.S. Geological Survey Water-Resources Investigations report.

Travel time for solutes, upper Sabine River Basin, Texas, April 16-20, 1972. This report has been released as a U.S. Geological Survey open-file report.

Ground-water pollution in the vicinity of Toledo Bend Reservoir, Texas, progress report, 1972. This report has been released as a U.S. Geological Survey open-file report.

Effects of ground-water development on the proposed Palmetto Bend Reservoir. This report will be published as a U.S. Geological Survey Water-Resources Investigations report.

Artificial recharge operations on the southern High Plains of Texas and New Mexico. This report will be published as a U.S. Geological Survey Water-Resources Investigations report.

Time of travel of solutes, field observations of water quality, and suspended-sediment data for stream reaches in the Trinity River Basin, Texas, July 31 - August 14, 1972. This report will be released as a U.S. Geological Survey open-file report.

A network for continuous monitoring of water quality in the Sabine River Basin. This report will be released as a U.S. Geological Survey open-file report.

Ground-water pollution studies at Toledo Bend Reservoir. This report will be published as a U.S. Geological Survey Water-Resources Investigations report.

Preliminary report on land-surface subsidence in the Baytown area, Texas. This report has been released as a U.S. Geological Survey open-file report.

Analog model study of the Houston District, Texas. This report will be published as a Texas Water Development Board report.

Water-budget studies of lower Mesilla Valley and El Paso Valley, El Paso County, Texas. This report will be released as a U.S. Geological Survey open-file report.

SELECTED LIST OF AVAILABLE REPORTS OF GENERAL INTEREST

U.S. Geological Survey Professional Paper 655-D: Geology and ground-water system in the Gila River Phreatophyte Project area, Graham County, Ariz., by W. G. Weist, Jr. Available from Superintendent of Documents - $1.75

U.S. Geological Survey Professional Paper 655-F: Subsurface hydraulics in the area of the Gila River Phreatophyte Project, Graham County, Ariz., by R. L. Hanson, with a section on aquifer tests by S. G. Brown. Available from Superintendent of Documents - 40¢

U.S. Geological Survey Professional Paper 686-A: Comparison of evaporation computation methods, Pretty Lake, Lagrange County, northeastern Indiana, by J. F. Ficke. Available from Superintendent of Documents - 70¢

U.S. Geological Survey Professional Paper 708: Ground-water hydraulics, by S. W. Lohman. Available from Superintendent of Documents - $2.00

U.S. Geological Survey Professional Paper 737: Reaeration in open-channel flow, by J. P. Bennett and R. E. Rathbun. Available from Superintendent of Documents - $1.00

U.S. Geological Survey Professional Paper 742: Characteristics of estuarine sediments of the United States, by D. W. Folger. Available from Superintendent of Documents - $1.25

U.S. Geological Survey Professional Paper 750-C: Geological Survey Research 1971, Chapter C. Available from Superintendent of Documents - $2.75

U.S. Geological Survey Professional Paper 750-D: Geological Survey Research 1971, Chapter D. Available from Superintendent of Documents - $2.50

U.S. Geological Survey Professional Paper 751-A: Preliminary results of injecting highly treated sewage-plant effluent into a deep sand aquifer at Bay Park, New York, by John Vecchioli and Henry F. H. Ku. Available from Superintendent of Documents - 30¢

U.S. Geological Survey Professional Paper 778: Embudo, N. Mex., birthplace of systematic stream gaging, by A. H. Frazier and Wilbur Heckler. Available from Superintendent of Documents - 45¢

U.S. Geological Survey Professional Paper 779: The story of the water supply for the Comstock, by H. A. Shamberger. Available from Superintendent of Documents - 70¢

U.S. Geological Survey Water-Supply Paper 1880-C: Summary of floods in the United States during 1967, by J. O. Rostvedt and others. Available from Superintendent of Documents - 75¢

U.S. Geological Survey Water-Supply Paper 1939-C: Electrical-analog analysis of the hydrologic system, Tucson Basin, southeastern Arizona, by T. W. Anderson. Available from Superintendent of Documents - 65¢

U.S. Geological Survey Water-Supply Paper 1979: Ground-water levels in the United States, 1965-69 - south-central states. Available from Superintendent of Documents - $1.00

U.S. Geological Survey Water-Supply Paper 1988: Definitions of selected ground-water terms - revisions and conceptual refinements, by S. W. Lohman and others. Available from Superintendent of Documents - 25¢

U.S. Geological Survey Water-Supply Paper 1994: Quality of surface waters of the United States, 1966 - Parts 7 and 8, Lower Mississippi River Basin and western Gulf of Mexico Basins. Available from Superintendent of Documents - $3.50

U.S. Geological Survey Water-Supply Paper 1999-L: Factors contributing to unusually low runoff during the period 1962-68 in the Concho River Basin, Texas, by S. P. Sauer. Available from Superintendent of Documents - 35¢

U.S. Geological Survey Water-Supply Paper 2005: Model hydrographs, by W. D. Mitchell. Available from Superintendent of Documents - 45¢

U.S. Geological Survey Water-Supply Paper 2009-B: Hydrologic interpretations based on infrared imagery of Long Island, N.Y., by E. J. Pluhowski. Available from Superintendent of Documents - 30¢

U.S. Geological Survey Water-Supply Paper 2014: Quality of surface waters of the United States, 1967 - Parts 7 and 8, Lower Mississippi River Basin and western Gulf of Mexico Basins. Available from Superintendent of Documents - $3.50

U.S. Geological Survey Water-Supply Paper 2019-A: Estimating steady-state evaporation rates from bare soils under conditions of high water table, by D. C. Ripple, Jacob Rubin, and T. E. A. van Hylckama. Available from Superintendent of Documents - 30¢

U.S. Geological Survey Water-Supply Paper 2025: Glossary of selected terms useful in studies of the mechanics of aquifer systems and land subsidence due to fluid withdrawal, by J. F. Poland, B. E. Lofgren, and F. S. Riley. Available from Superintendent of Documents - 15¢

Circular 601-G: Real-estate lakes, by D. A. Rickert and A. M. Spieker. Free on application to the U.S. Geological Survey, Washington, D. C. 20244

Circular 648: Reports and maps of the Geological Survey released only in the open files, 1971, by B. A. Weld, K. T. Iseri, and G. W. Brett. Free on application to the U.S. Geological Survey, Washington, D. C. 20244

Circular 649: Preliminary appraisal of ground water in storage with reference to geothermal resources in the Imperial Valley area, Calif., by L. C. Dutcher, W. F. Hardt, and W. R. Moyle, Jr. Free on application to the U.S. Geological Survey, Washington, D. C. 20244

Circular 650: Energy resources of the United States, by P. K. Theobald, S. P. Schweinfurth, and D. C. Duncan. Free on application to the U.S. Geological Survey, Washington, D. C. 20244

Circular 671: A land-use classification system for use with remote-sensor data, by J. R. Anderson, E. E. Hardy, and J. T. Roach. Free on application to the U.S. Geological Survey, Washington, D. C. 20244

Circular 676: Estimated use of water in the United States in 1970 by C. R. Murray and E. B. Reeves. Free on application to the U.S. Geological Survey, Washington, D. C. 20244

U.S. Geological Survey Hydrologic Atlas 215: Analysis of the ground-water system by electrical-analog model, Avra Valley, Pima and Pinal Counties, Ariz., by Otto Moosburner. Available from Superintendent of Documents - $1.00

U.S. Geological Survey Hydrologic Atlas 434: Analog simulation of water-level declines in the Sparta Sand, Mississippi Embayment, by J. E. Reed. Available from Superintendent of Documents - $1.00

U.S. Geological Survey Bulletin 1298: Geology of the northern Franklin Mountains, Tex. and N. Mex., by R. L. Harbour. Available from Superintendent of Documents - $2.25

Texas Water Quality Board Publication 72-05: Subsurface waste disposal in Texas, by Robert Hill. Available on application to Texas Water Quality Board.

Texas Water Development Board Report 157: A survey of the subsurface saline water of Texas, Volume 1, prepared by Core Laboratories, Inc., Consulting and Engineering Dept., Dallas, Tex. Distributed by Texas Water Development Board.

SUMMARY OF COOPERATION

Organizations assisting in collecting data under cooperative agreements with the Geological Survey are:

Texas Water Development Board. Harry P. Burleigh, Executive Director; John H. McCoy, Chairman; Marvin Shurbet, Vice-Chairman; Robert B. Gilmore, Milton T. Potts, Carl Illig, and W. E. Tinsley, Members.

Texas Highway Department. B. L. DeBerry, State Highway Engineer; Charles E. Simons, Chairman; Herbert C. Petry, Jr. and D. C. Greer, Members.

Pecos River Commission. Horace M. Babcock, Commissioner representing the United States and Chairman; R. B. McGowen, Jr., Commissioner representing Texas; and John B. Walker, Commissioner representing New Mexico.

Sabine River Compact Administration. W. H. Robinson, Chairman; R. J. Palmer and H. B. Myers for Louisiana; and J. M. Syler and George Smith for Texas.

County of Dallas. Judson Shook, Director of Public Works.

City of Dallas. Monroe McCorkle, Director of Public Works.

City of Fort Worth. J. M. Graham, Director of Public Works.

City of Houston. E. B. Cape, Director of Public Works.

Assistance in the form of funds or services is furnished by the following Federal agencies:

Bureau of Reclamation, Department of the Interior.

Bureau of Sport Fisheries and Wildlife, Department of the Interior.

National Oceanic and Atmospheric Administration, Department of Commerce.

Environmental Protection Agency.

Department of Housing and Urban Development.

International Boundary and Water Commission, United States and Mexico, U.S. Section.

National Park Service, Department of the Interior.

Soil Conservation Service, Department of Agriculture.

U.S. Air Force, Department of Defense.

U.S. Army, Department of Defense.

U.S. Army, Corps of Engineers, Albuquerque District, New Mexico.

U.S. Army, Corps of Engineers, Fort Worth District, Texas.

U.S. Army, Corps of Engineers, Galveston District, Texas.

U.S. Army, Corps of Engineers, New Orleans District, Louisiana.

U.S. Army, Corps of Engineers, Tulsa District, Oklahoma.

Veterans Administration.

Assistance in the form of funds or services is rendered by the following organizations through the Texas Water Development Board:

Cities		
Abilene	Clyde	Graham
Alice	Corpus Christi	Houston
Arlington	Dallas	Lampasas
Austin	El Paso	San Angelo
Brady	Gainesville	Wichita Falls
Cleburne	Galveston	

Other Agencies

Athens Municipal Water Authority

Bexar-Medina-Atascosa Counties Water Improvement District No. 1

Bistone Municipal Water Supply District

Brazos River Authority

Colorado River Municipal Water District

Dallas County

Dallas Power and Light Company

Dow Chemical Company

Edwards Underground Water District

Mitchell Development Corporation of the Southwest

Greenbelt Municipal and Industrial Water Authority

Guadalupe-Blanco River Authority

Harris County Flood Control District

Houston Lighting and Power Company

Lower Colorado River Authority

Lower Neches Valley Authority

Palo Pinto County Municipal Water District No. 1

Red Bluff Water Power Control District

Reeves County Water Improvement District No. 1

Richmond Rice Association

Sabine River Authority of Texas

San Antonio City Public Service Board

San Antonio City Water Board

San Antonio River Authority

San Jacinto River Authority

South Texas Water Company

Tarrant County Water Control and Improvement District No. 1

Texas Electric Service Company

Tom Green County Water Control and Improvement District No. 1

Trinity River Authority of Texas

Upper Guadalupe River Authority

Upper Neches River Municipal Water Authority

West Central Texas Municipal Water District

White River Municipal Water District

Wichita County Water Improvement District No. 2

Wood County

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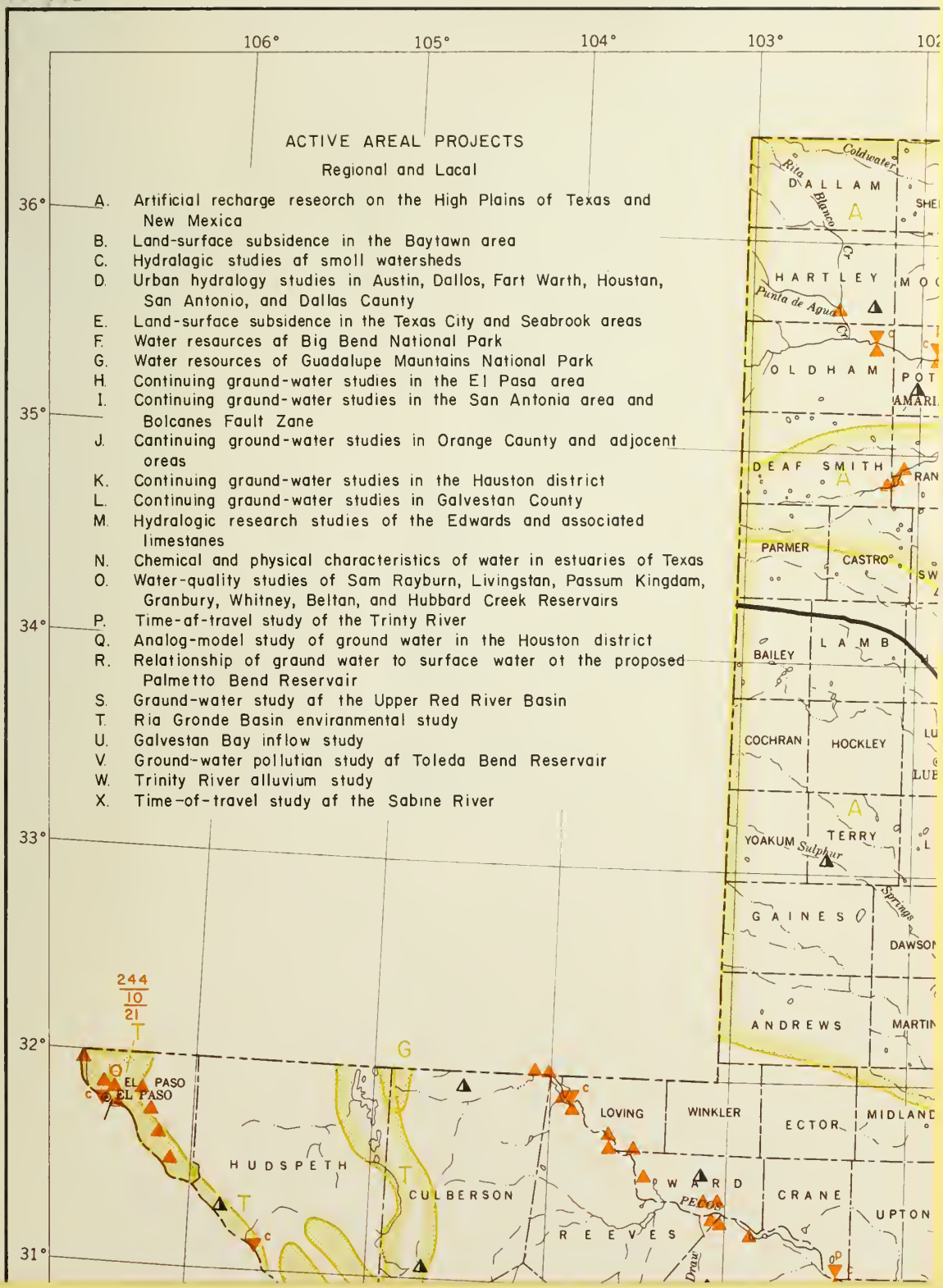
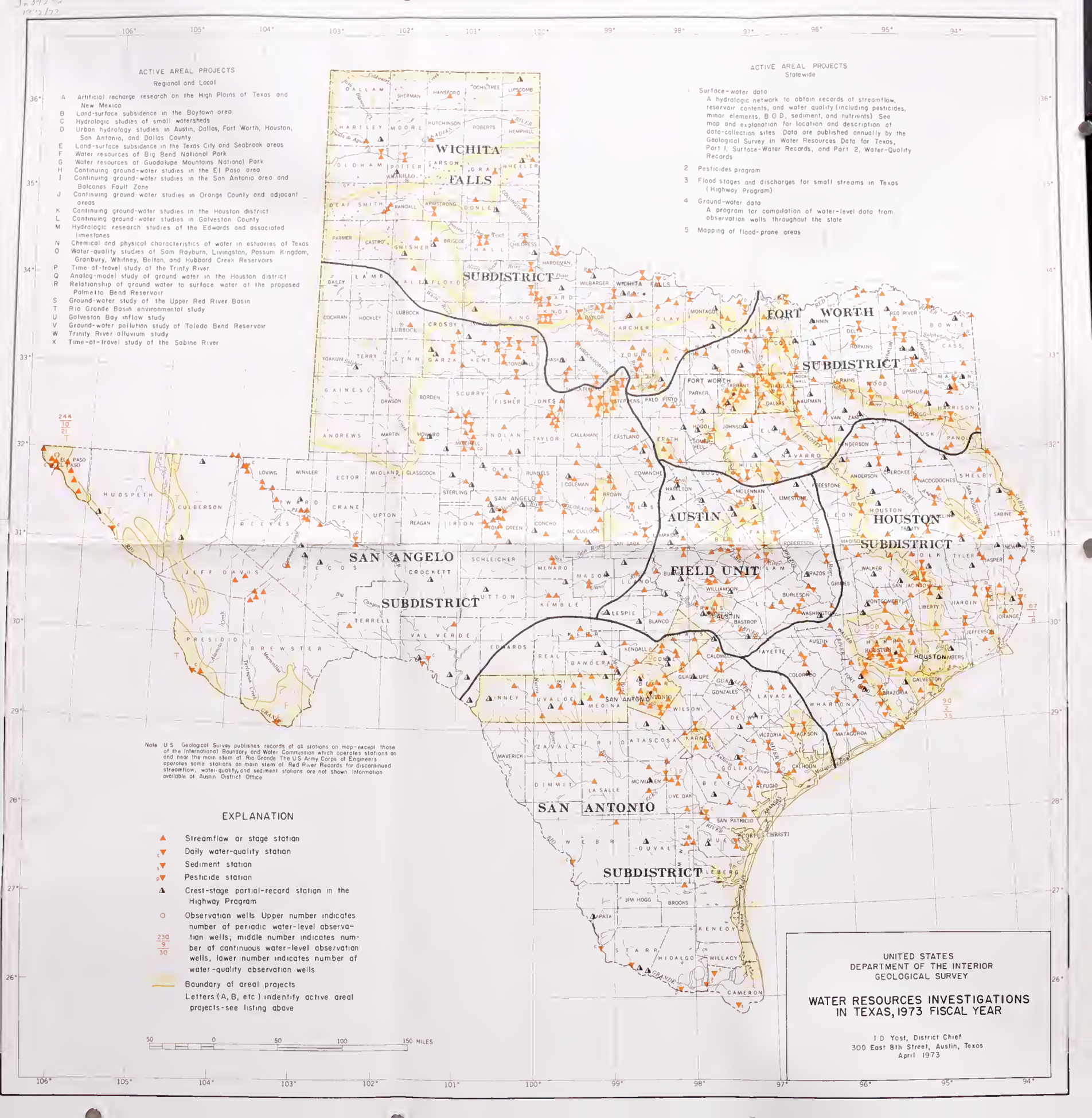


ACTIVE AREAL PROJECTS

Regional and Local

A. Artificial recharge research on the High Plains of Texas and New Mexico
B. Land-surface subsidence in the Baytown area
C. Hydrologic studies of small watersheds
D. Urban hydrology studies in Austin, Dallas, Fort Worth, Houston, San Antonio, and Dallas County
E. Land-surface subsidence in the Texas City and Seabrook areas
F. Water resources of Big Bend National Park
G. Water resources of Guadalupe Mountains National Park
H. Continuing ground-water studies in the El Paso area
I. Continuing ground-water studies in the San Antonio area and Balcones Fault Zone
J. Continuing ground-water studies in Orange County and adjacent areas
K. Continuing ground-water studies in the Houston district
L. Continuing ground-water studies in Galveston County
M. Hydrologic research studies of the Edwards and associated limestones
N. Chemical and physical characteristics of water in estuaries of Texas
O. Water-quality studies of Sam Rayburn, Livingston, Possum Kingdom, Granbury, Whitney, Belton, and Hubbard Creek Reservoirs
P. Time-of-travel study of the Trinity River
Q. Analog-model study of ground water in the Houston district
R. Relationship of ground water to surface water at the proposed Palmetto Bend Reservoir
S. Ground-water study of the Upper Red River Basin
T. Rio Grande Basin environmental study
U. Galveston Bay inflow study
V. Ground-water pollution study of Toledo Bend Reservoir
W. Trinity River alluvium study
X. Time-of-travel study of the Sabine River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ACTIVE AREAL PROJECTS
Statewide
1 Surface-water data
A hydrologic network to obtain records of streamflow, reservoir contents, and water quality (including pesticides, minor elements, B O D, sediment, and nutrients) See map and explanation for location and description of data-collection sites Data are published annually by the Geological Survey in Water Resources Data for Texas, Part 1, Surface-Water Records, and Part 2, Water-Quality Records
2 Pesticides program
3 Flood stages and discharges for small streams in Texas (Highway Program)
4 Ground-water data
A program for compilation of water-level data from observation wells throughout the state
5 Mapping of flood-prone areas
WICHITA FALLS SUBDISTRICT
FORT WORTH SUBDISTRICT
AUSTIN FIELD UNIT
HOUSTON SUBDISTRICT
SAN ANGELO SUBDISTRICT
SAN ANTONIO SUBDISTRICT
Note U S Geological Survey publishes records of all stations on map-except those of the International Boundary and Water Commission which operates stations on and near the main stem of Rio Grande The U S Army Corps of Engineers operates some stations on main stem of Red River Records for discontinued streamflow, water-quality, and sediment stations are not shown Information available at Austin District Office
EXPLANATION
Streamflow or stage station
Daily water-quality station
Sediment station
Pesticide station
Crest-stage partial-record station in the Highway Program
Observation wells Upper number indicates number of periodic water-level observation wells; middle number indicates number of continuous water-level observation wells, lower number indicates number of water-quality observation wells
Boundary of areal projects
Letters (A, B, etc) indentify active areal projects-see listing above
50 0 50 100 150 MILES
UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES INVESTIGATIONS IN TEXAS, 1973 FISCAL YEAR
I D Yost, District Chief
300 East 8th Street, Austin, Texas
April 1973

UNIVERSITY OF ILLINOIS-URBANA
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